Escapements 10

Paul Shrouder FBHI looks at the Brocot escapement.

Everyone should know all about the Brocot escapement, shouldn't they? After all it is the one that is open to view in the dial ground of millions of French clocks.

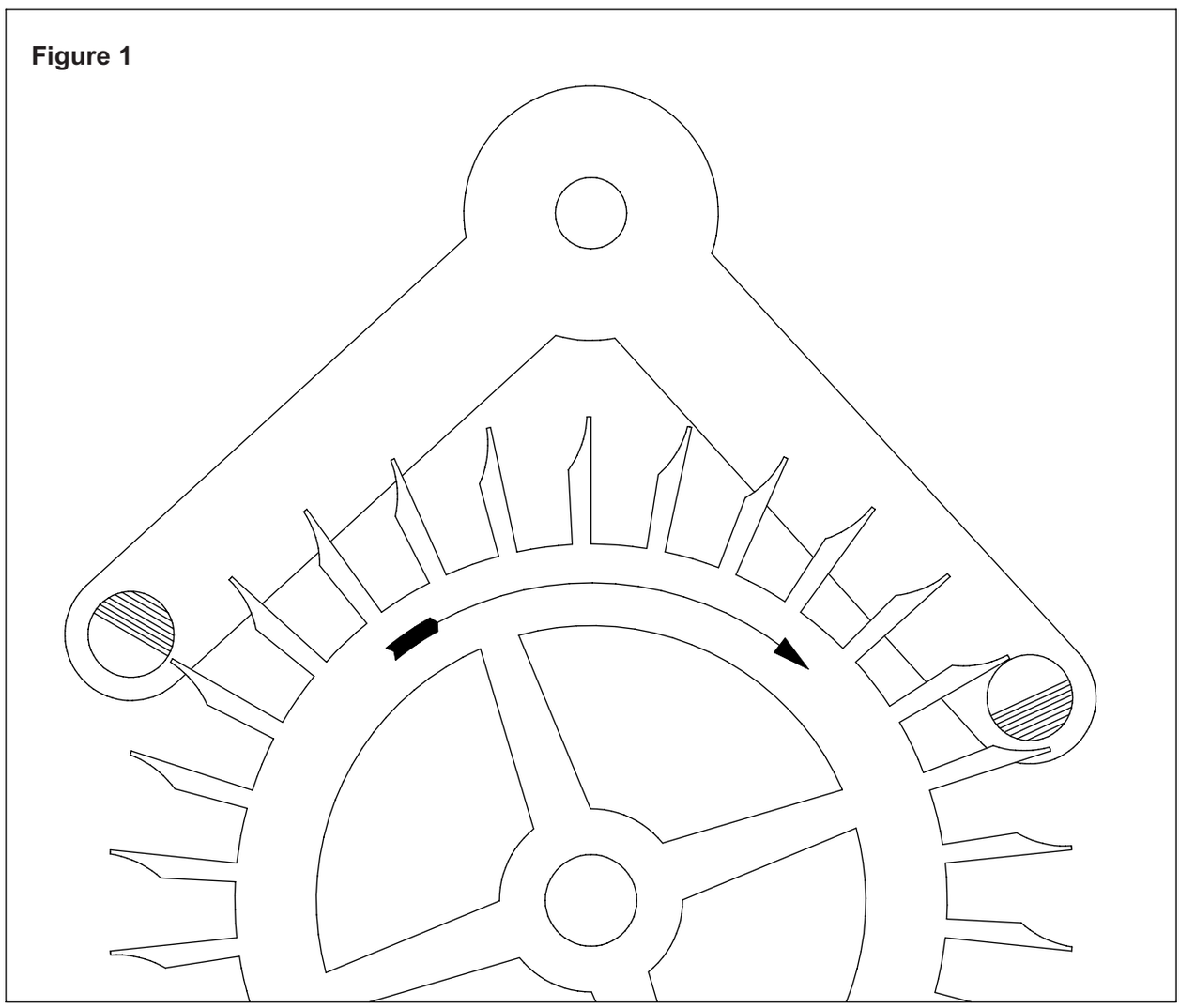
I bet that by now everyone who reads this has a picture in their head of a black slate clock of one style or another that shows the pallets and escape wheel held by the two curved and scrolled bridges set into the dial ground, with the red garnet or ruby pallet stones moving serenely in and out of the elegant escape wheel teeth. This is one of the nicest of escapements and operates with a good amplitude, ample supplementary arc and little friction. To my mind this is one of the most elegant inventions to come from the field of horology. **Figure 1** shows the escapement with which most of us are familiar.

This is often thought of as a dead beat escapement, and though it can be made as a true dead beat, it is generally made to include a small amount of recoil. If one thinks about it, the pallets move in to and out of the escape wheel in a curve centred on the pallet staff, and if the escape wheel teeth are radial (to the wheel centre) then the wheel must move back and forth a little to accommodate the arc through which the pallet stone is moving.

The main faults that one sees when these come in to the repairer are wear on the pallet pivots, and wear to the pallet impulse faces (the curved side of the pallet). This escapement generally comes in two types; the one in which the pallets are set in between the plates as normal leaving the dial clear, and the other with the pallets and escape wheel visible in the dial centre. The former of these usually (I'm tempted to say 'always'), has steel pallet pins set in to a brass frame, and these are almost always worn to a greater or lesser degree. The pallet pins in the dial-mounted, or visible, escapement are usually made of a fairly hard stone like garnet or carnelian, and even these will wear.

One delightful version of this came in for repair a few weeks ago; this is the little known lesser impulsed Tocorb escapement. In this version (according to a previous repairer) the stones were set in the pallet frame backward. This was a very clever thing to do as it makes maximum use of the clear assertion of M. Achille Brocot, that the escapement performs better with a slight recoil. If it performs better with a slight recoil it must perform perfectly with the maximum recoil. I can't fault his logic! **Photos 1 & 2** show this clock as it came in for repair. I have not yet had the courage to check out the other mysteries of this unusually modified piece. Making a new pair of pallets is really quite easy and, in this day and age with the cheap availability of diamond lapping equipment, there is no excuse for putting

Figure 1



1. An example of the very rare 'Tocorb' escapement..

2. M Marti would despair.

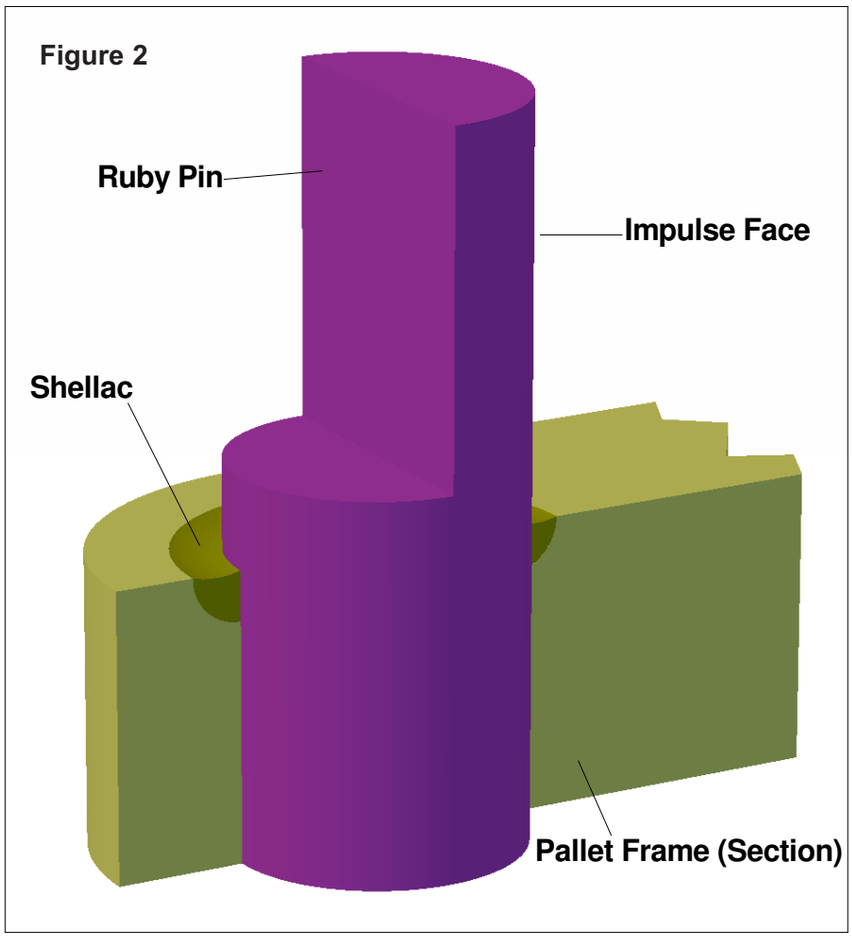
steel pins into a visible escapement. Unless it is missing, or to be made new, the pallet frame should be there and usable; only the pins will need to be made to replace the worn ones.

New pallet pins in a variety of sizes are available off the shelf from Meadows & Passmore, but if the size you require is not available you need to make them for yourself. Once again the good old standby laser rod is already round section and is available in lots of sizes. If it does need lapping down to a smaller diameter then that can be done. If you wish to make a small rod from a bulle of garnet or similar, then by all means do so.

Once upon a time, it could be taken for granted that the frame was the correct one for the clock and escape wheel. That does not necessarily hold true today as there has been so much bodging by amateurs, and mixing and matching by unscrupulous dealers, that it is necessary to check out the suitability of the frame and the diameter of the pins required to fit in it.

To find the diameter of pin to fit a given escape wheel, simply turn up a bit of brass rod until it just fits between two of the escape wheel teeth with visible clearance. The freedom will be the drop, and thus is lost impulse, so you do not want too much. When you are happy that the pin diameter and the clearance feel about right, with the clearance being minimal yet definite, you should measure the diameter with a micrometer and finish your round, blank, pin, to this size. **Figure 1** will give you a good idea of what to look for – the shaded area being the reduced section where the pin is cut back to exactly half the diameter.

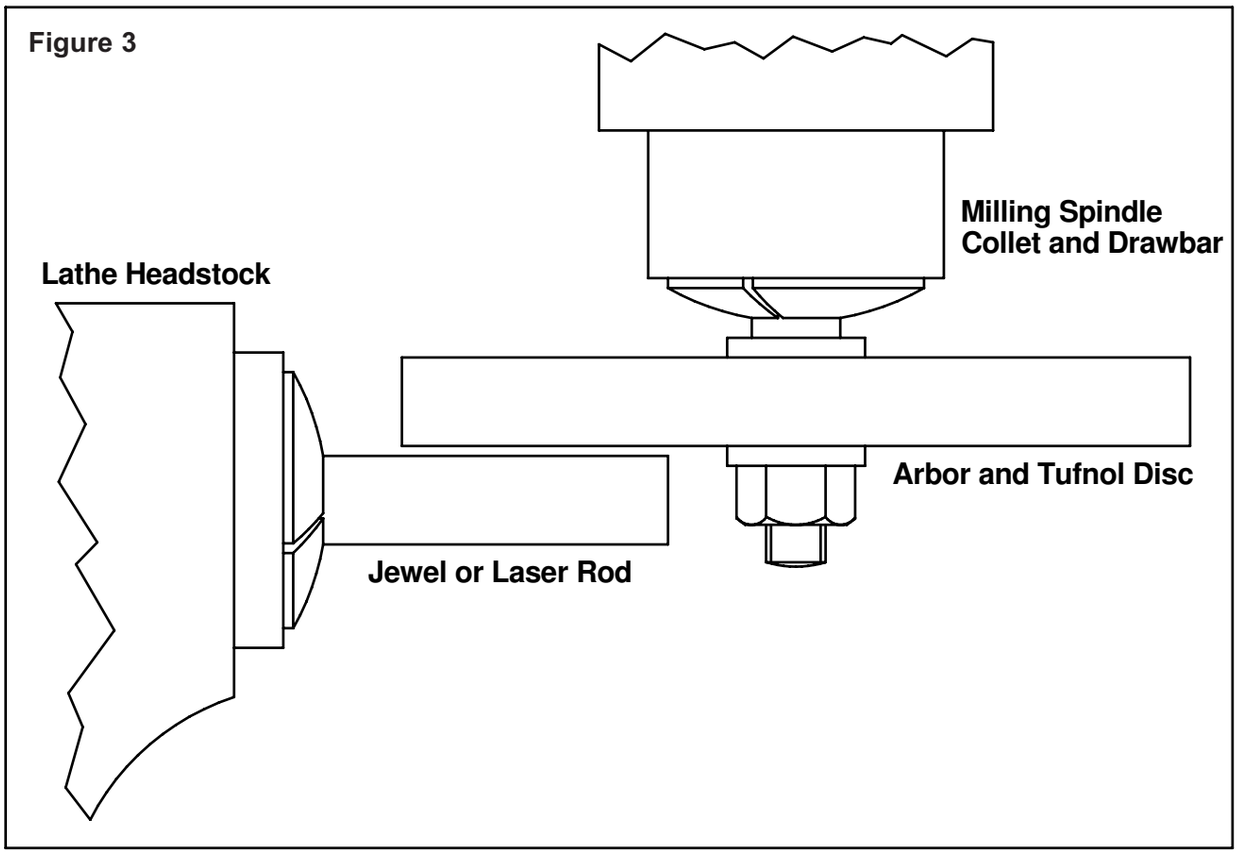
I shall not insult your intelligence by describing the hardening and tempering of a steel pin, but I suppose we should cover the use of diamond lapping equipment to produce a garnet or corundum pin. Bear in mind that the ruby or steel pin should be a good sliding fit in the hole in the pallet frame. **Photo 3** shows a very drunken looking pin in the entrance pallet frame. You will also see that it is badly chipped at the drop-off corner. The discharge pallet is of course broken off completely, so both need replacing.



The too small pin leaning over causes me to wonder if the frame is the right one for the clock, or if the pallet stones are the wrong ones for an original frame. **Figure 2** shows how the stones were designed to fit into the pallet frame, smoothly and with no play, and the shellac run into a small depression not unlike an oil sink. This will allow the stone to be turned or twisted to adjust the drops and clearance with the shellac softened so that they remain upright to the frame, making them easy to adjust.

So first of all, I'm going to make a test piece as described earlier, in order to find the right diameter. If my measuring is correct then the round bar should be a close sliding fit in the pallet frame and then I'll know what I'm going to produce.

Basically the same laps that produced and altered the pallet stones described in the article on the lever escapement **(HJ February 2009)** will be used to make the impulse pin for the Brocot. The reduction



in diameter of a piece of laser rod that is too great in diameter will be demonstrated to start with.

With the laser rod (or the piece of bulle previously 'roughed') held in a collet in the lathe head, arrange for a lap about 2 inches diameter and about ¼ inch thick to be carried on a collet that will fit in the milling spindle with the axis vertical, and bring the lap down to the rod until it nearly touches as shown at **Figure 3**. With the lathe turning in the normal direction arrange for the lap to rotate clockwise as viewed from above. The lap should turn at about 600 to 800 rpm and the lathe at about 400 rpm any faster and the lapping compound tends to fly off before it gets bedded into the lap. Once the lap is charged these speeds can be increased. One does, of course, need to advance the lap as the diameter of the rod is reduced, and it is necessary to keep the lap lubricated with something like paraffin. (Another reason to keep the speeds down.) There are proprietary brands of lubricant available from the manufacturers and suppliers of the diamond lapping compounds, but they are generally expensive and paraffin does just as good a job.

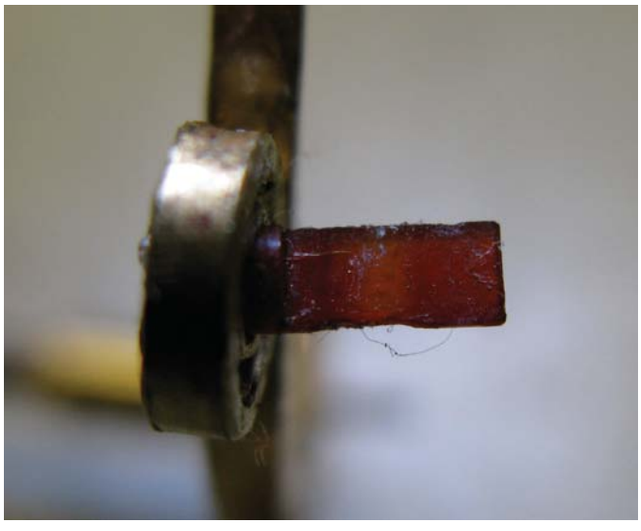
Reduction from 3mm dia. to 2mm dia. Should take about 20 to 30 minutes if one is using a grade of diamond paste between 6 micron and 10 micron and one does have to sit with the job to keep the lubricant at the right level. When the rod measures about 3/100 mm over the finished size change the lap for one using a much finer paste, say 1 micron, and start the polishing to get a good finish. Eventually you might drop to one tenth micron for the final finishing polish.

It cannot be stressed too much that the main difficulty with this job is keeping the laps clean and uncontaminated with dust that can scratch the stone. Apparently, most dust is silica and will leave nasty pits in the surface if allowed to come into contact with the job. Once a lap is contaminated it will have to be turned down (skimmed) and re-charged with the appropriate paste. Keep your laps in polythene bags and colour-code them so that you know the size of grit on each one.

If you want to buy less diamond pastes remember that a hard lap with a fine paste will often cut faster than a soft lap with a coarse paste, so you can use, say, 6 micron paste on an iron lap, followed by a 6 micron paste on a copper lap and then a 6 micron paste on a tufnol lap to get the final polish. This is because the diamond grit beds in to the lap surface and if the lap is soft the grit beds in further and thus leaves less diamond sticking out to do the cutting, so the cut is shallower – 'simples'!

Once the rod is the correct diameter and has a nice polish the last stage is to cut ½ of it away. I should say 'cut ¼ of it away' as half the rod length is left round and only ½ of the remainder is cut back to leave the flat.

Place the lap that was first used to reduce the rough rod to correct diameter in the lathe head with a little lubricant on it and



3. Definitely not a sliding fit in the hole!

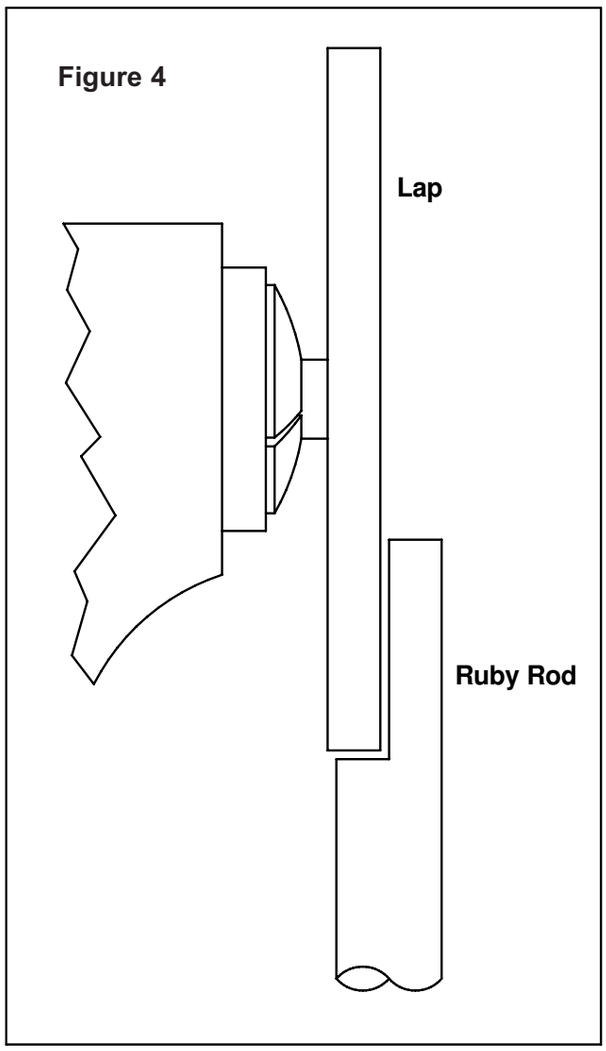
holding the polished rod in a pin chuck offer it up to the rotating lap, support it with the finger and press lightly to start wearing away the rod, **Figure 4**. Measure frequently as you approach the half way point, you do not want to go too far. Keep the lap charged with paste and keep the lubricant at the right level; you'll know if you have too much on the lap as there will be a black line straight down the centre of your face from the throw-off, and if there is insufficient you will take too long to complete the cut. All in all, you should be able to make one stone in a morning easily, have your lunch and then do the other stone in the afternoon, setting them correctly in the pallet frame before knocking off at 5pm.

A few observations might be in order here, I have a little 8mm Wolf Jahn lathe that is used for all diamond lapping and polishing. This preserves the Boley & Leinen for fine watch work and keeps the bearings in good order. The diamond lathe has little need for accuracy as the lapping is either self centring or working on one side of the wear only. Also beware when you buy diamond paste as the price reflects the density of diamond particles on the paste and so what seems to be a cheap buy is actually a paste that contains less diamond and therefore means you need to work with it for longer to get the same result.

Setting up this escapement is easy once the new stones are in place, both 'flats' should point directly in to the centre of the wheel to start with when holding the tooth in the locked position, but if they do catch the tooth backs or if there is too much drop all you do is just warm the shellac and gently turn the offending stone in the appropriate direction. Here you will appreciate the need for a close sliding fit in the socket as the stone will stay at 90 degrees to the frame. If it were loose you would be fighting a wobbly stone that would be very difficult to set correctly.

This article concludes the Escapement Series.

A special thanks to John Warbey for providing his article on the Riefler Escapement and for all the drawings which have accompanied this series.



Harrison Project Update

The project members have done an immense amount of work on the regulators in the past few months. Ken Johnson's articles on the analysis of the escapements show just how much has been achieved in advancing our understanding of this important clock and of Harrison's thinking behind it. However we need so much more than this, and to this end we decided that a visit to the National Maritime Museum would be needed in order to obtain accurate first hand measurements. These would allow us to make certain that our current data; derived from second hand sources was either correct or needed improving and also would allow us to measure accurately those parts of the clock that we had no data for.

Thus four representatives of the Harrison Project, Bill Connor, Ken Johnson, Peter Hastings, and myself went to the Royal Astronomical Society in London for a meeting with the owners of the RAS regulator. Jonathan Betts was also there representing the National Maritime Museum (who are the custodians of the clock) as he will be instrumental in our accessing the clock when we finally get to examine it.

Professor Mike Edmunds Cardiff University (Emeritus) and Peter Hingley, the librarian for the RAS, made us feel very welcome; showing us into the library and offering us coffee. After an informal round of introductions we got down to business.

Photograph courtesy of National Maritime Museum, Greenwich.

The outcome was most satisfactory as it turned out that all three groups had the same goals in mind. Our request will now go before the RAS Board for consideration, and with the support expressed by Jonathan Betts, Mike Edmunds and Peter Hingley we are hopeful that a comprehensive documentation and analysis of the original clock will be completed before much longer.

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